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ABSTRACT

Previous investigations on Piagetian cognitive levels among college students both within and across academic disciplines have not addressed the issue of possible differences in cognitive levels between traditional undergraduates and older returning students. Piagetian cognitive levels were studied among traditional- and nontraditional-age college business and education majors to examine levels of cognitive reasoning in the two groups. The Arlin Test of Formal Reasoning (ATFR) was administered to 69 business majors, 114 elementary and secondary education majors, and 34 science education majors. Scores on individual tests were classified into concrete, transitional and formal levels of cognitive reasoning according to performance across eight reasoning abilities or formal schemes. These are complex thought processes identified by Piaget as developing during the middle teens. They take the following forms: multiplicative compensations (volume); correlations; probability; combinatorial thinking; proportion; momentum; equilibrium; and frames of reference. ATFR scores were also analyzed by age, business, business or education major, and gender. Results indicated significant differences across age groups in the level of cognitive reasoning abilities and between males and females, but no significant differences between academic majors. Findings suggest a need for revisions of teaching methodologies for both secondary and college level courses, with an emphasis on problem solving and conceptual skills. Includes 21 references (LPT)

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Cognitive Levels of Reasoning Among Traditional and Non-Traditional Age College Students

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Running head: COGNITIVE LEVELS AMONG COLLEGE STUDENTS

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Abstract

Piagetian cognitive levels were studied among traditional and non-traditional age college business and education majors. Significant differences occurred across age groups in the level of cognitive reasoning abilities but no significant differences occurred between academic majors. Significant differences also occurred between males and females. Results suggest a need for revisions of teaching methodologies for both secondary and college level courses, with an emphasis on problem solving and conceptual skills.

Cognitive Levels of Reasoning Among Traditional and Non-traditional Age College Students

Piaget and Inhelder (1958) described three basic cognitive processes which characterize higher order reasoning or adult intelligence. These processes include the ability for 1) hypothetical-deductive logic; 2) inductive reasoning; and 3) abstract reflection. Higher order reasoning, or formal operations, however, also includes additional logical skills or schemes.

Previous research on Piagetian cognitive levels among college students has indicated that large percentages of undergraduates have not attained the formal operational reasoning skills usually assumed by both faculty and administrators (Chiapetta, 1976; Epstein, 1980). As early as 1962, Elkind reported difficulties in reasoning among college students. Kolodiy (1974) reported problems in the use of formal operations among students enrolled in college physics and chemistry courses. Similarly, Killian (1979) reported that only 25% of 106 participants in a freshman science course were reasoning at the formal level. Thornton and Fuller (1981) reported difficulties college students

encountered in the use of proportional reasoning. In the field of teacher preparation, a study by Reyes (1986) indicated that the majority of preservice teachers had not attained formal reasoning. Reyes and Alter (1989) reported concrete operational reasoning among pre-service teachers at two universities. Reyes has further reported significant differences between high risk students' and general students' use of concrete, transitional and formal reasoning, with more concrete reasoning among the high risk students (October 19, 1989; personal communication). Silverman and Creswell (1982) have also reported that preservice teachers do not show consistent use of formal reasoning. Cafolla (1986) has reported similar results among business majors in computer programming.

These previous investigations both within and across academic disciplines, however, have not addressed the issue of possible differences in cognitive levels between traditional age undergraduates and older returning students. The primary purpose of this research was to examine levels of cognitive reasoning in these different groups, but analyses by business and education majors and gender were also included.

Method

Both traditional and non-traditional age college students at a Midwestern university served as participants in this study. These men and women included a total of 69 business majors, 114 elementary and secondary education majors and 34 science education majors. The Arlin Test of Formal Reasoning (ATFR) was administered during class time on a voluntary basis to all participants. Both validity and reliability of The Arlin Test have been established elsewhere (Arlin, 1986). Individual test scores were classified into concrete, transitional and formal levels of cognitive reasoning, according to performance across eight reasoning abilities or formal schemes.

Scores on the ATFR were analyzed by age, business or education major, and gender. Age was divided into five categories: under twenty-one, twenty-one to twenty-five, twenty-six to thirty, thirty-one to thirty-five, and over thirty-five years.

Results

Significant differences across age groups occurred by ATFR scores. A significantly higher proportion of the students over age twenty-six achieved scores indicating

formal reasoning in comparison with the students age twenty-five and under [X^2 (16, N = 230) = 28.15, $p<.03$]. A Pearson correlation between age groups and ATFR levels was also significant ($r = .18$, $p<.002$). Table 1 shows the frequencies and percentages of students performing at the different cognitive levels by age. Space constrictions necessitated combining the thirty to thirty-five and over thirty-five age groups in this table.

Insert Table 1 about here

No significant differences occurred in the proportion of business and elementary/secondary education majors by ATFR level [X^2(4, N = 183) = 2.43, $p<.65$]. Pearson's r also failed to yield a significant correlation between ATFR level and a major in these disciplines ($r = .03$, $p<.34$).

No significant differences occurred in the proportion of science education majors and non-science education majors by ATFR level [X^2 (4, N = 148) = 1.34, $p<.85$]. Pearson's r also failed to yield a significant correlation between ATFR

level and a major in science education ($r = .017$, $p < .42$). These results are interesting because at face value the items on the ATFR appear to be biased in favor of students with more experience in the physical sciences. These results appear to support the claims made by Arlin, that the test measures more general cognitive abilities.

Significant differences occurred in the use of ATFR levels by gender [X^2 (4, $N = 230$) = 11.62, $p < .02$]. Pearson r also yielded a significant correlation between ATFR level and gender ($r = .13$. $p < .02$). Out of a total of 80 men, 16.2% used concrete operational reasoning, 12.5% used transitional reasoning, and 71.2% used formal reasoning. Out of 150 women, 17.3% used concrete operational reasoning, 24.0% used transitional reasoning and 58.6% used formal reasoning. Possible reasons for these results are discussed below.

Discussion

As stated above, the ATFR classifies individual scores into cognitive levels on the basis of the use of eight reasoning abilities or formal schemes. These are complex thought processes which Piaget identified as developing during the middle teens. College educators have tended to

assume these reasoning abilities in their students, but these results as well as those of others indicates that they should not be taken for granted. An examination of the formal schemes suggests that their full attainment may require more varied experience than most adolescents encounter before entering college. The following definitions of the schemes are adapted from Arlin.

Multiplicative Compensations (Volume)

This scheme refers to the understanding that if there are two or more dimensions to be considered in a problem, then gains or losses in one dimension are made up for by gains or losses in the other dimensions.

Correlations

This scheme is the ability to conclude either a positive or inverse relationship between two variables.

Probability

This scheme involves an understanding that the likelihood of an event occurring depends upon a combination of variables as well as certain preconditions.

Combinatorial Thinking

This scheme is the ability to follow consistent procedures in order to account for all possible combinations of a given number of variables.

Proportion

This scheme refers to the understanding of the equality of ratios. When applied to spatial problems, for example, it is used in the creation of models built to scale.

Momentum

This scheme involves the ability to infer the existence of a conservation by observing its effects, as, for example, in the transfer of energy from one billiard ball to another.

Equilibrium

This scheme refers to the ability to maintain a balance among variables, as, for example, in physics or literary plots.

Frames of reference

This relativism of reasoning involves the ability to maintain two or more apparently discrepant viewpoints or systems and to perceive the relationships among them, as, for example, in cultural values.

The subtest scores of these eight schemes on the ATFR showed that a larger percentage of the students under age twenty-five were not consistently using these cognitive processes in their approach to the problems, in contrast to the students over twenty-six.

Piaget himself described the difficulty between the ages of fifteen and twenty in making the transition to adult formal thought. He suggested that in order for the cognitive structures to develop to their fullest potential, a whole series of exchanges and a stimulating environment were as necessary as they were for the formation of earlier cognitive operations. "All normal individuals are capable of reaching the level of formal structures on the condition that the social environment and acquired experience provide the subject with the cognitive nourishment and intellectual stimulation necessary for such a construction," (1975, p.113). In the late teens, therefore, opportunities for a whole series of discussions and mutual exchange in regard to problem solving becomes crucial.

The results of this study suggest that the younger students have not encountered these intellectually stimulating and challenging experiences Piaget saw as necessary for the fostering of formal reasoning. It is interesting that a common complaint among these college students was that most of their education has focused on memorizing rather than on problem solving and creative assignments.

The similar findings in the students' cognitive abilities across academic majors is not surprising, because these business and education majors came from similar educational backgrounds in their pre-college years. In these students, choice of major was apparently related to personal interest, rather than to reasoning skills.

The finding of gender differences in the use of formal reasoning raises some important issues. Schwebel (1972, 1975) has also reported these differences, which could be explained by a deficit on the part of females in opportunities for the kinds of problem solving situations which Piaget described. Observational studies of classroom situations have reported that teachers give more attention, criticism and praise to boys than to girls (Sadker & Sadker, 1985) and that teachers interact less with both minority and non-minority females than they do with both minority and non-minority males (Sadker, Sadker & Klein, 1986). Teachers ask boys more questions (Jackson & Lahaderne, 1976) and they ask boys more <u>abstract questions</u> (Sikes, 1972, highlight ours). Girls with excellent math abilities have been observed to receive less instructional interactions than their male classmates (Eccles, MacIver & Lange, 1986).

Such differential experience prior to entering college could account for the gender differences among the younger participants. Among the non-traditional female students, different types of problem solving experience at home or in the workplace could account for differences among the women themselves. Most of the women over twenty-six demonstrated use of the formal schemes, suggesting a broader experience than the younger women. It is interesting, however, that the only three participants over age thirty who reasoned at the concrete operational level were women who had been in sex-stereotyped positions, which provided little opportunity or need for hypothetical or abstract reflection.

Future Directions

The cognitive levels found among the traditional college students were similar to those reported elsewhere. These findings that 40% of these students are using concrete and transitional thought processes suggests a need for a more interactive and problem solving teaching methodology in both high schools and in college. The similar levels among the younger non-traditional students age twenty-five and under suggests that these students have instructional needs similar to their traditional age classmates.

The increased use of formal reasoning among the students over age twenty-six raises some important challenges for higher education. Age may not be the "key variable" in cognitive advance, but the accrued interactive problem solving experience of older non-traditional students may facilitate the development of higher order cognitive skills. In turn, these skills enhance the potential for academic success. Kasworm (1990), in a review of 98 studies on non-traditional students, reported that the demographics of undergraduate education have changed, with more adult learners enrolled. These returning students bring with them challenges for both administrators and professors and their views of the capabilities of non-traditional students in a college or university setting.

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TABLE 1

Frequencies of Students: Age x Cognitive Level

	Below 21	21-25	26-30	Over 31
Cognitive Level				
Concrete	19	17	0	3
	(20.7%)	(18.9%)	(0.0%)	(10.0%)
Transitional	18	20	5	3
	(19.6%)	(22.2%)	(27.8%)	(10.0%)
Formal	55	53	13	24
	(59.7%)	(58.8%)	(72.2%)	(80.0%)